

# NOTES ON COMPARATIVE BODY SIZE, REPRODUCTIVE EFFORT AND AREAS OF MANAGE- MENT PRIORITY FOR THREE SPECIES OF *KACHUGA* (REPTILIA, CHELONIA) IN THE NATIONAL CHAMBAL SANCTUARY<sup>1</sup>

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(With a plate & three text-figures)

Record lengths of carapace have been reported from the River Chambal for *Kachuga tentoria circumdata* (26.5 cm), *K. dhongoka* (48.0 cm) and *K. kachuga* (49.0 cm). The ratios, carapace length/breadth and plastron length/breadth were similar in all three species. The ratio carapace length/shell height was less in *K. tentoria* as it bears a high dome. Out of 13 areas of nesting identified for management-priority, 23.0% were shared by all three species and 46.1% by *K. tentoria* and *K. dhongoka*. Although biometrical features relating 'body capacity' to 'egg mass occupancy' in the body indicate similarities between *K. tentoria* and *K. kachuga*, only *K. tentoria* is known to lay more than one clutch per season while others lay only one. The incubation period is 5-8 months for *tentoria* as winter-laying is there, but is 2 months for the others. The clutch sizes are 4-9 (*tentoria*), 21-35 (*dhongoka*) and 11-18 (*kachuga*). Egg length  $\times$  breadth cm  $\times$  weight g are: 4.7  $\times$  2.7  $\times$  21.4 (*tentoria*), 5.9  $\times$  3.6  $\times$  44.2 (*dhongoka*) and 7.0  $\times$  4.1  $\times$  57.4 (*kachuga*).

## INTRODUCTION

Three species of *Kachuga* (Emydidae) namely, *K. tentoria circumdata*, *K. dhongoka* and *K. kachuga* occur in the National Chambal Sanctuary along the River Chambal of the Gangetic system (Rao and Singh *in press*). In the following we present data on the body size of these chelonians with preliminary analysis of the observations on their reproduction. Besides, a list is given of the nesting areas that are of significance to a Manager for the species in the Sanctuary.

The National Chambal Sanctuary, created in 1978 extends from Jawaharsagar Dam (Rajasthan) to Kota barrage (Rajasthan) and

after a gap of 18 km, from Keshoraipatan (Rajasthan) through Pali (M.P./Rajasthan) to Pachhnada (Uttar Pradesh). The total length of the river inside the Sanctuary is about 600 km.

## MATERIALS AND METHODS

Three live and 22 caracases of *K. t. circumdata* and three caracases each of *K. dhongoka* and *K. kachuga* were collected outside water during survey trips made by boat and foot between October 1983 and July 1984. The shell measurements of all specimens were taken as described by McRae *et al.* (1981) and the data were used to compare the maximum sizes reported in literature for different species (Smith 1933, Pritchard 1979, and Daniel 1983), and determine the similarities in certain biometrical ratios. The carapace

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length and carapace width (=plastron width) were taken as straightline measurements.

Four gravid females, represented by two of *tentoria* and one from each of the two other species were examined at the ovary (for methods see, Moll and Legler 1971. Rao 1982) to determine the nesting frequency and collect comparative data on clutch and egg sizes in relation to the length of the females.

In order to compare the species-wise reproductive effort, the approximate body capacities (BV) have been considered against the approximate egg-clutch mass (EM) and egg-clutch occupancy (EV). The following methods were used in calculating BV, EM and EV.

$$PL \times PB \times SH,$$

$$BV = \frac{\quad}{2},$$

$$EM = CS \times EW, \text{ and } EV = CS \times EL \times EB$$

In the above, PL and PB are the mean lengths and breadths of plastron, SH, the mean shell height; CS, the mean clutch size (mean number of eggs per clutch); EL and EB, the mean length and breadth of eggs, and EW the mean egg weight (g). All measurements are in centimetres.

The incubation period was determined by direct corroboration of nesting activities, period of commencement of embryonic development and periods of sightings of hatchlings.

Different nesting areas and their management priorities were determined during the surveys from the extent of nesting activities and predation pressure.

## RESULTS

**Size and biometrical ratios.** The average shell measurements of dead and live specimens of hardshelled turtles collected in the Chambal river are presented in Table 1. The mean carapace lengths were 24.65 cm (*Kachuga tentoria circumdata*), 44.6 cm. (*K. dhongoka*) and 47.6 cm (*K. kachuga*). The

maximum length of the carapace in the three species were 26.5 cm, 48.0 cm and 49.0 cm, respectively. The plastron was always smaller than the carapace but attached to the latter at such a point in the front that it protruded out a little behind the rear end of the carapace. Therefore, the total lengths (Table 1) were larger than the carapace length. The ratios carapace length/width were 1.38, 1.38 and 1.32 for *K. tentoria circumdata*, *K. dhongoka* and *K. kachuga* respectively (Table 1). The ratio, plastron length/width were 1.26, 1.27 and 1.25 respectively and the ratio, carapace length/shell height (body depth) were 2.24, 2.73 and 2.34. For one male *K. kachuga* the ratios were: carapace length/width 1.25, plastron length/width 1.14 and carapace length/shell height 2.36. The male (29.5 cm carapace length) was caught by net near Babu Singh ka gher (Table 2) on 5 December 1983. The turtle, being in its breeding colours, had six red longitudinal stripes along the neck, a pair of oblong yellow spots on the throat and the head was brilliantly red on the top and bluish on the sides.

**Nesting areas, Distribution pattern.** *Kachuga* are very scarce in the river upstream of Pali. Downstream of Pali although pre-nesting activities were seen, no nests were located. The first major nesting site was located at Baroli (Table 2), 57 km downstream of Pali.

Out of the total 13 identified nesting sites (Table 2) three (23.0%) were common to all three species, and six (46.1%) were common to *K. tentoria* and *K. dhongoka*. There were no regular distance-intervals between any two nesting sites (Figs. 1 and 3).

**Nesting frequency.** Three predated nests, about a week old, discovered on 29 October 1983 were the earliest record of nesting by *Kachuga tentoria*. Fresh nests (confirmed from fresh turtle tracks) were located on 5

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TABLE 1

BODY AND EGG BIOMETRICS OF *Kachuga tentoria circumdata*, *K. dhongoka* and *K. kachuga*. FOR SL. NO. 1 THROUGH 8 n=25 (*tentoria*), 3 (*dhongoka*) AND 3 (*kachuga*). SIZES IN CM AND WEIGHT IN G (RANGE IN PARENTHESES)

Sl. No.	Aspects	<i>K. t. circumdata</i>	<i>K. dhongoka</i>	<i>K. kachuga</i>
1	Carapace length CL	24.65 (22.0-26.5)	44.6 (44.0-48.0)	47.6 (46.0-49.0)
2	Carapace length in:			
(a)	Smith 1933	23.0 ( <i>K. tectum/K. t. tentoria</i> )	40.0	39.0
(b)	Pritchard 1979	17.7 (7") ( <i>K. tentoria</i> )	40.6 (16")	40.6 (16")
(c)	Daniel 1983	23.0 ( <i>K. tecta/K. tentoria</i> )	40.0	39.0
3	Carapace width CB	17.78 (16.5-19.5)	32.3 (28.0-35.0)	36.0 (35.0-37.0)
4	Plastron length PL	22.45 (21.5-24.0)	41.16 (40.5-44.0)	45.0 (43.0-46.0)
5	Total length TL	24.8 (22.0-27.5)	44.8 (40.0-47.5)	49.3 (47.5-50.5)
6	Shell height SH	11.0 (8.0-12.5)	16.3 (15.5-17.5)	20.3 (20.0-21.0)
7	Anal width AB	4.0 (3.5-5.0)	5.3 (5.0-5.5)	6.0 (5.5-7.0)
8	Anal notch AN	3.25 (3.0-3.5)	6.6 (6.0-7.0)	6.7 (6.5-7.0)
9	CL/CB	1.38	1.38	1.32
10	PL/CB	1.26	1.27	1.25
11	CL/SH	2.24	2.73	2.34
12	Clutch size CS	5.95 (4-9) n=20	23.64 (21-35) n=31	15.5 (11-18) n=4
13	Egg length EL	4.755 (4.5-5.0) n=119	5.993 (5.18-6.62) n=220	7.049 (6.65-7.54) n=62
14	Egg width EB	2.754 (2.60-2.90) n=119	3.611 (3.20-4.12) n=220	4.161 (3.76-4.56) n=62
15	Egg weight EW	12.40 (19.8-23.3) n=119	44.21 (36.5-57.3)	57.42 (56.5-58.3)
			Mean egg weight from 22 clutches	Mean egg weight from 4 clutches
16	BV cu. cm	2195.38	10835.16	16443.0
17	EM sq. cm g	127.33	1045.12	890.01
18	EV sq. cm	77.91	511.58	454.62
19	P <sub>1</sub> %	5.79	9.64	5.41
20	P <sub>2</sub> %	3.5	4.7	2.7

TABLE 2

MAJOR NESTING SITES OF *Kachuga* SP. IDENTIFIED IN NATIONAL CHAMBAL SANCTUARY, 1983-84. d, *K. dhongoka*; k, *K. kachuga* AND t, *K. tentoria circumdata*. FOR *tentoria*, \*\*FIRST NESTING, \*\*\*SECOND NESTING. al, ALLUVIUM; bs, BUSH AND OS, OPEN SAND.

Sl. No.	Location	Reference km *	River bank (M.P./U.P./Rajasthan)	Site Description		Species-wise use	Dates of nesting data collection
				Shore length m	Nature of nesting ground		
1	Baroli	57	M.P.	500	os/bs	t,d,k	1.2.84/3.4.84 ***
2	Rahu	113	M.P./Raj.	20/100	os	t	22.11.83/24.11.83**
3	Batesura	123	M.P.	100	os	t	24.11.83**
4	Bharrah	131	M.P.	500	os	t,d	6.3.84/11.3.84/ 25.3.84***
5	Devgadh (Sarsaini)	165	Raj.	250	os	t	3.11.83**
6	Basai Dang	173	Raj.	500	os	t	30.10.83**
7	Gorkha	205	Raj.	100	os	d	5.4.84
8	Tigri-Rithaura	209	Island (M.P./Raj.)	20 sq. m	al	d	29.3.84/5.4.84
9	Papripura	214	M.P.	2000	os	d	5.4.84
10	Babu Singha Gher	226	M.P. (Islet)	500/100 sq. m	os	t,d,k	4.12.83/26.1.84*** 30.1.84/31.1.84
11	Pureini	229	Raj.	1000	os	t,d	5.12.83/3.1.84*** 31.3.84
12	Kenjra	296	U.P.	1500	os/bs	t,d	31.1.84*** 8.4.84
13	Gyanpura	356	M.P.	200	os	t,d	2.3.84*** 13.4.84

\* In reference to Palighat (Parbati-Chambal confluence) (Fig. 1).

December (10), 3 January (1) and 28 January (1). After 28 January no further nesting activities were noted. From all the above nesting records, it was presumed that nesting season of *Kachuga tentoria circumdata* extended from October through January (Fig. 2).

A female *Kachuga tentoria circumdata* (25 cm carapace length) wandering on land at 0730 hrs on 24 November contained six (3 + 3 right and left) oviductal eggs with a mean weight of 23.3 g and length × width 50±0.564 (50.0-51.5) × 29.08±0.205

(29.0-29.5) mm. The ovaries contained only six fresh corpora lutea (right 4 and left 2). Four ovarian follicles of ovulatory size (25-26 mm) were also present suggesting the production of at least two clutches per season.

On the same day (24 November) at 1600 hrs, a female turtle (carapace length 23.0 cm) was captured on land when it was returning after egg laying. The nest contained 7 eggs with the mean measurements of 46.0±0.925 (45.0-47.0) × 28.0±0.534 (27.0-29.0) mm. Mean egg weight was 22.3±0.527 (22.0-



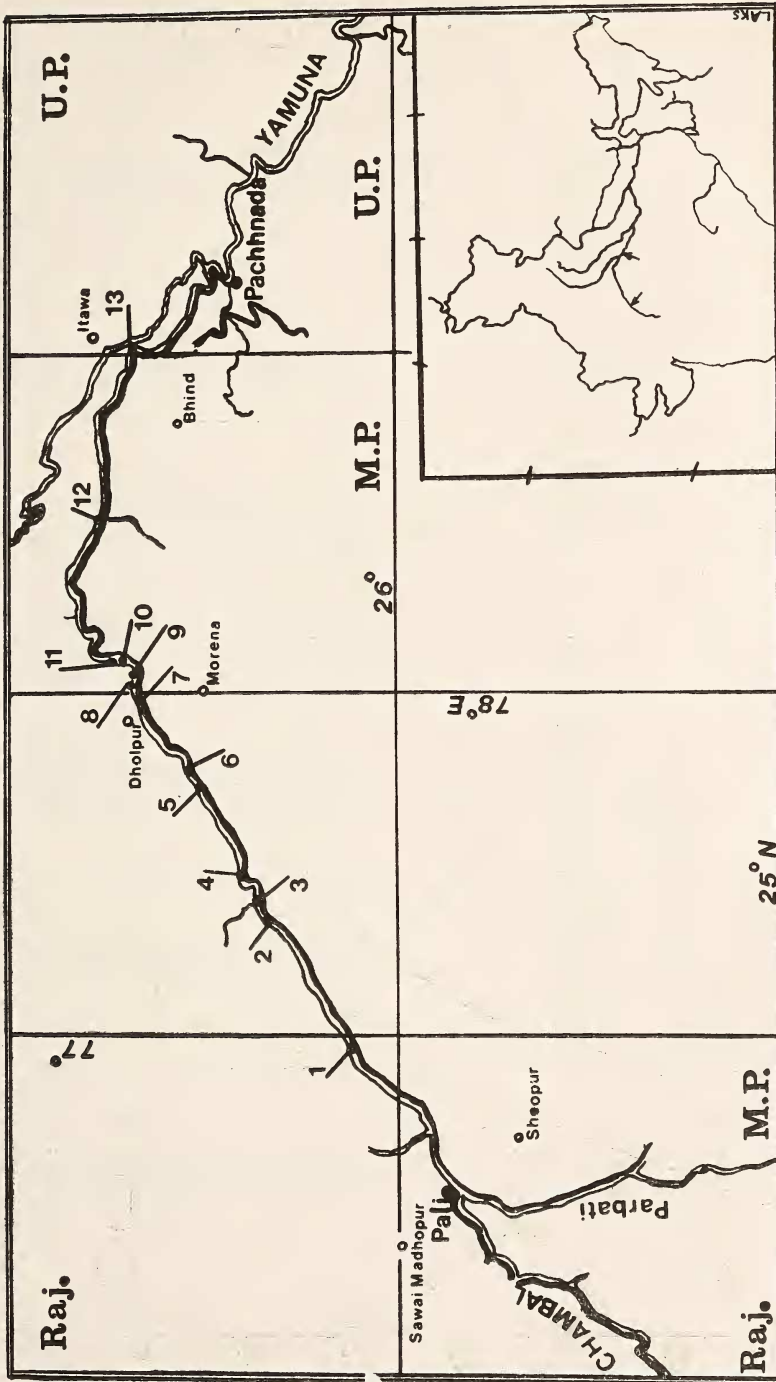


Fig. 1. River Chambal (National Chambal Sanctuary) from Pali (Chambal-Parbati confluence) to Pachhnada showing important nesting areas of *Kachuga* sp. (1-13, as in Table 2). M.P., Raj. and U.P. are the states of Madhya Pradesh, Rajasthan and Uttar Pradesh through which the river flows.

*Inset:* Position of River Chambal (arrows) in the Gangetic system.

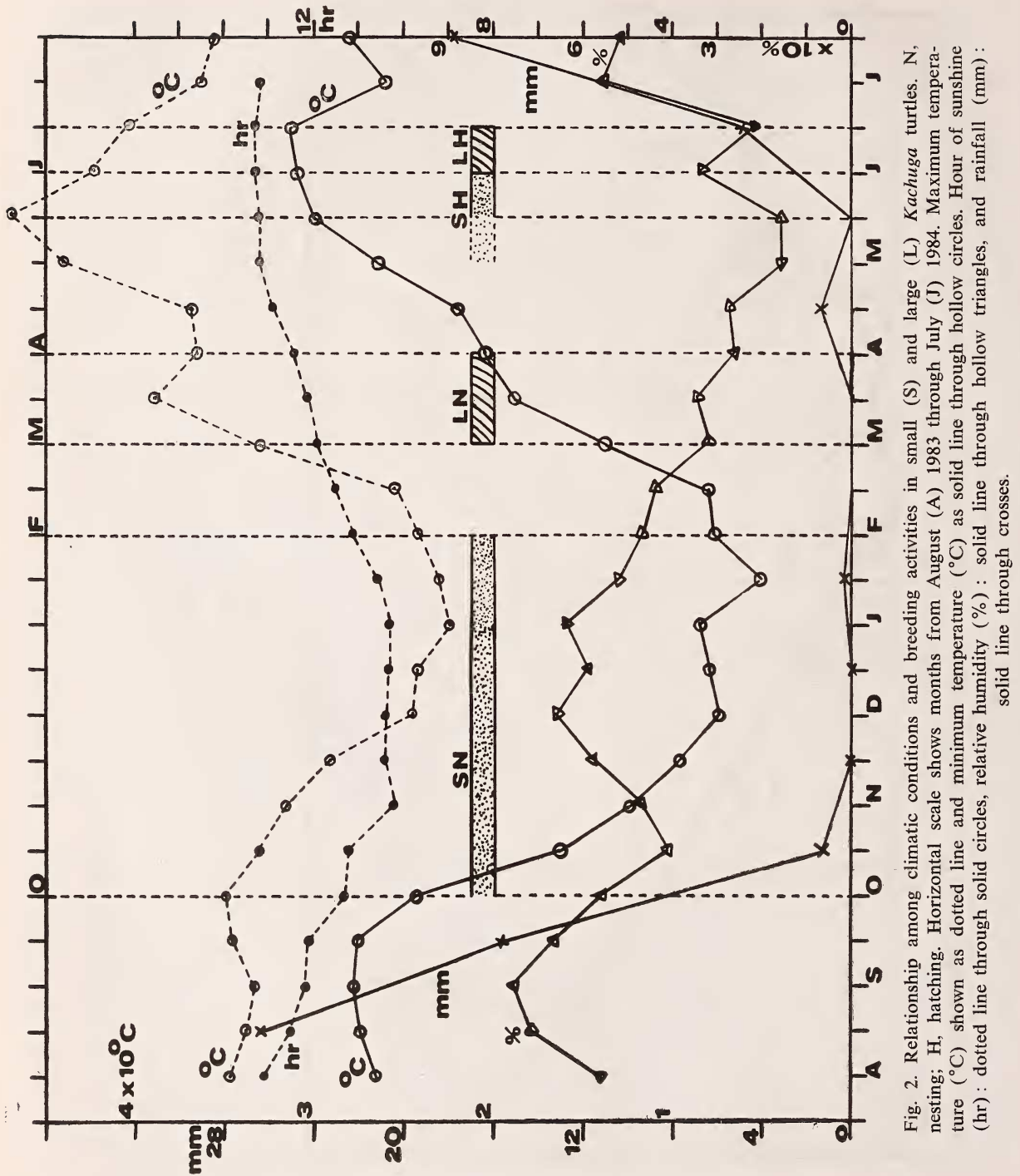


Fig. 2. Relationship among climatic conditions and breeding activities in small (S) and large (L) *Kachuga* turtles. N, nesting; H, hatching. Horizontal scale shows months from August (A) 1983 through July (J) 1984. Maximum temperature (°C) shown as dotted line and minimum temperature (°C) as solid line through hollow circles. Hour of sunshine (hr) : dotted line through solid circles, relative humidity (%) : solid line through hollow triangles, and rainfall (mm) : solid line through crosses.

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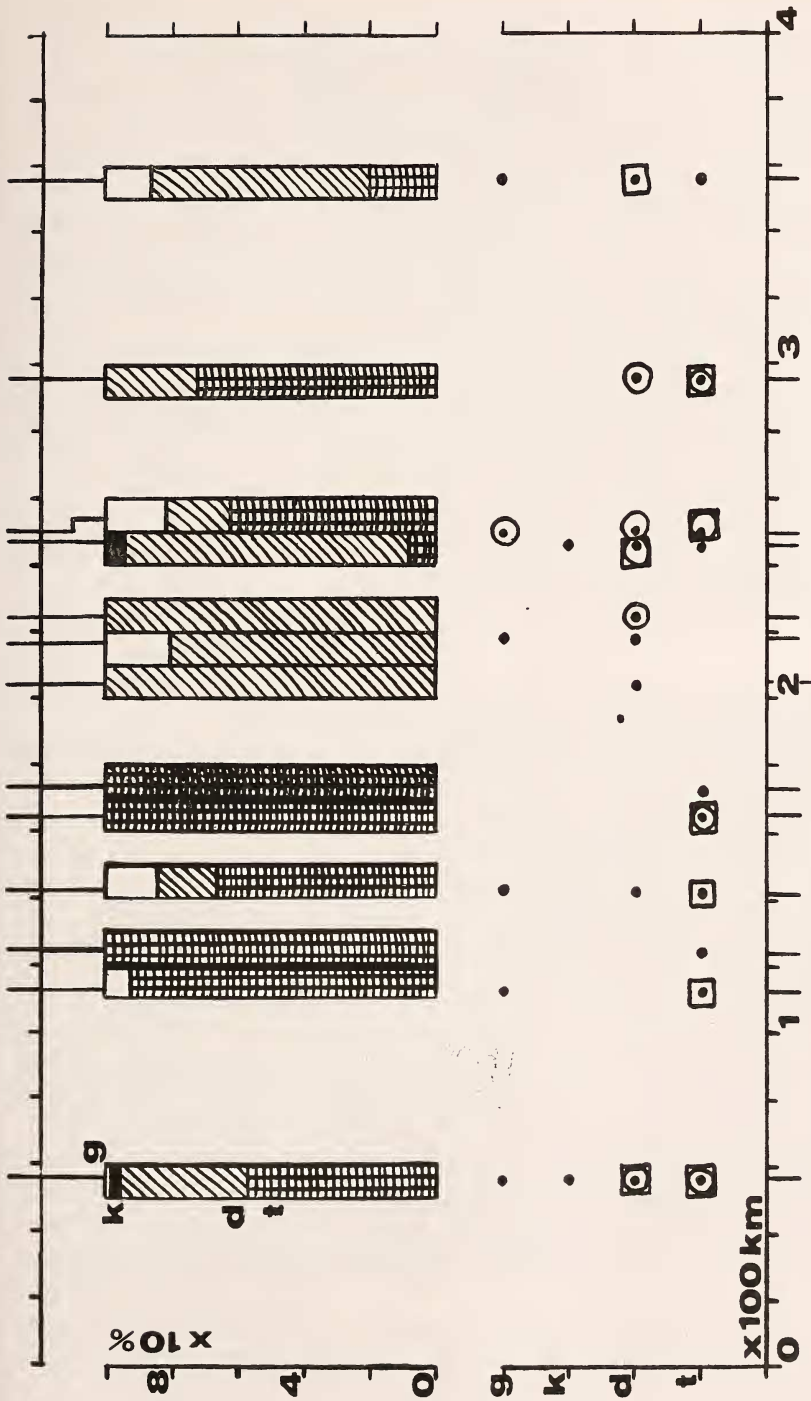


Fig. 3. Extents of nesting (lower fig.) and extents of utilisation of a nesting site in National Chambal Sanctuary during 1983-1984.

*Kachuga tentoria circumdata* (t, small squares);

*Kachuga dhongoka* (d, slanting hatch);

*Kachuga kachuga* (k, dark) and

*Gavialis gangeticus* (g, open)

In the lower figure small solid dots for 1-9 number of nests, circle with dot: 10-19 nests, square with dot: 20-29 nests, square with dotted circle: above 30 nests. Larger vertical lines over the horizontal scales of distance indicate the exact position of different nesting sites.

23.5) g. The ovaries contained seven corpora lutea (right 4 and left 3) and four ovarian follicles of ovulatory size (24-26 mm) indicating two clutches per season.

Clutch size and egg size of *Kachuga t. circumdata* are shown in Table 1. The clutch size was determined mostly from the examination of natural nests (18 no.) and also from the data on eggs found in the oviduct (n=1) of live- and in the body cavity (n=1) of dead-specimen (see above). Mean clutch size was 5.95 with a range of 4-9. Eggs were elliptical and with a very thin shell cracking to pressure. Mean egg length was 47.5 mm, width 27.54 mm and weight 21.40 g. One female *K. t. circumdata*, dead presumably a week before location (12 December 1983) had eight shelled eggs free inside the body. The female measured 26.5 cm in carapace length and the eggs 46.1 × 29.8 mm (Plate 1).

The breeding season in *K. kachuga* is expected to commence by the beginning of December because the male caught on 5 December was already in its breeding colours. The nesting season of both the large *Kachuga* sp. (*dhongoka* and *kachuga*) was March-April.

The first nest of *Kachuga dhongoka* was found on 11 March 1984 and after 31 March no fresh nesting was recorded. The nests of large *Kachuga* sp. looked the same as that of small *Kachuga* sp. except that these were of large dimension and most often on ground with relatively more silt.

Eggs in the size range of 66-75 mm in length with small clutch size (11-18) were the eggs of *Kachuga kachuga*. These eggs were 37-45 mm wide and 56-58 g in weight. Mean clutch size of *Kachuga dhongoka* was 23.64 and of *Kachuga kachuga* was 15.5. Egg dimensions and clutch size are shown in Table 1. Eggs of *K. dhongoka* were small, 51-66 mm × 32-41 mm × 36-57 g (Plate 1).

The body cavity of one *K. dhongoka* was examined late in the nesting season. The turtle was dead about a week before location (31 March 1984) and had 21 free eggs inside the body. The carapace length of the female was 40.5 cm and the eggs were 60.7 × 38.7 cm.

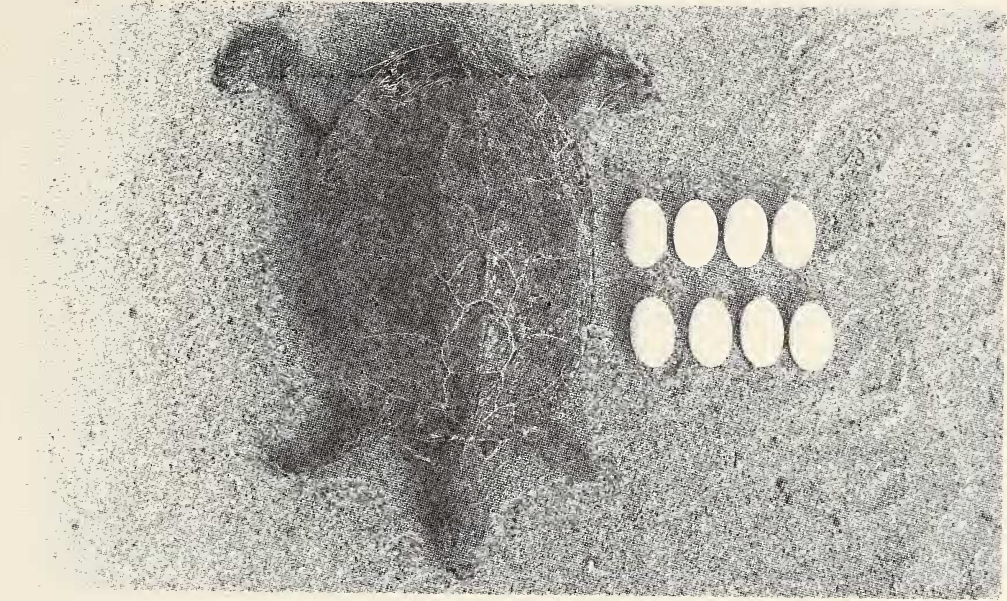
A *Kachuga kachuga* suspected to be dead the night before location (5.4.1984) had well calcified eggs, 4 in the right oviduct and 7 in the left. Except a few atretic follicles there were no follicles greater than 20 mm but there were 3 fresh corpora lutea in the right ovary and 8 in the left ovary. The female measured 49.0 cm in carapace length, and the eggs were 66.5 mm × 37.6 mm.

**Incubation period.** The minimum and maximum ambient temperature during the nesting season of *K. tentoria* (October-January) ranged as 3.5-29°C and 17-39°C, respectively (Fig. 2). The prevalent conditions of humidity, rainfall and photoperiod (sunshine) during nesting are shown in Fig. 2.

The nest temperature during winter nesting was very low (17°C-25°C) for embryo development. Periodical checks of eggs in an open hatchery revealed that there was no embryo development until March but on 3 April, 1984 (30°C nest temperature) development had already commenced. In the wild hatchlings have been seen in May.

During the nesting season of *K. dhongoka* and *K. kachuga* (March-April) the ambient temperature ranged between 11°C and 46°C (Fig. 2), and the nest temperature 27.5°C-32°C. The development of embryo was noticed to have started within two days after egg-laying. Emerged hatchlings of *K. dhongoka* were recovered from nests at Tigri-Rithaura on 4.6.1984. Nesting at Tigri-Rithaura had occurred during the last week of March. The incubation period is estimated to be about sixty days.





Above: *Kachuga tentoria circumdata* with eggs recovered from the body.  
Below: A nest pit of *Kachuga dhongoka* with clutch of 23 eggs.





**Comparative reproductive effort.** The approximate BV of *K. tentoria*, *K. dhongoka* and *K. kachuga* were 2195.38, 10835.16 and 16443 respectively. The EM and EV were 127.33 and 77.91 (*K. tentoria*), 1045.12 and 511.58 (*K. dhongoka*) and 890.01 and 454.62 (*K. kachuga*) (Table 1).

The factor  $P_1$  showing the proportion (%) of EM in BV were 5.79, 9.64 and 5.41 for *tentoria*, *dhongoka* and *kachuga* respectively (Table 1). The factor  $P_2$  showing EV in BV were 3.5% (*tentoria*), 4.7% (*dhongoka*) and 2.7% (*kachuga*) (Table 1).

#### DISCUSSION

The largest specimen of *K. t. circumdata*, *K. dhongoka* and *K. kachuga* were 26.5 cm, 48.0 cm and 49.0 cm respectively. These sizes are distinctly larger than the sizes given in literature (Table 1). We would be interested to know when larger specimens are reported.

The ratios CL/CB and PL/CB are almost the same in all three species, perhaps a basic requirement in the design of the hardshelled turtles. Differences in CL/SH are evidently due to the extent to which the dome is raised above the plastron (SH) and this makes the differences in body-capacities.

The production of multiple clutches is to be expected for forms that have less body capacity and lay only a few eggs relatively less secure. In *K. t. circumdata* the nests are 83.5% times on flat sand banks close to mainland (Rao and Singh 1984) and the clutch of 4-9 eggs are only 16.13 cm below the surface. Therefore, a double effort is made in the species to ensure enough annual recruitment after sustaining all kinds of loss. These efforts are in the number of turtles and in laying double clutches spaced over a period of few months. Singh (1985) has also reported double nesting by *K. tentoria* in Mahanadi.

In the case of *K. dhongoka* the necessity to lay more than a clutch is waived because the size of the clutch and eggs are large. *K. kachuga*, although larger in size than *K. dhongoka* and produces larger and heavier eggs, the clutch size is small. The factors  $P_1$  and  $P_2$  as determined by comparing the body capacities and clutch-occupancies, are closely similar in the case of *K. tentoria circumdata* and *K. kachuga* indicating that *K. kachuga* may be having the potentiality to produce more than one clutch like *K. tentoria*. If, however, the results of examination of the ovaries and oviduct in the specimen of 5.4.1984 are any indication then we can at the best conclude that between October and July *K. kachuga* lays only one clutch and it is not known if a second clutch is ever laid.

Hatchling turtles of *Chrysemys picta* and *Pseudemys scripta* (Gibbons and Nelson 1978) and *Chelydra serpentina* (Newman 1906) are known to over-winter in the nest itself, and Congdon *et al.* (1983) suspect a direct relationship between the emergence tactics of hatchlings and the level of lipid in the eggs. Singh (1985), based on his notes on terrestrial activities in *K. tentoria* of the River Mahanadi, suspected that the species perhaps hibernates. Based on the present study it is suspected that the eggs of *K. t. circumdata* laid early in the season (October) may be undergoing some development before the onset of the extremely low temperatures of December-January but during the winter, development proceeds at an extremely slow rate. The eggs laid during November and later have to remain dormant until the temperature rises to 30°C as has been observed in developing embryos of April. The above situation would lead to the hatching of *K. t. circumdata* spread over a few months that would ensure less competition. In any case, the incubation period is suspected to be 5-8